Performance Criteria for Student Outcomes

Computer Engineering Bachelor of Science

Outcome 1

An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Performance Indicator	Unsatisfactory	Marginal	Satisfactory	Exemplary
a) Identify and formulate engineering problems	Unable to identify engineering problems in an assignment or project.	Can identify and formulate at least half of the engineering problems in an assignment or project.	Can identify and formulate all of the engineering problems in an assignment or project.	Can identify and formulate all of the problems in an assignment or project, and can integrate their solutions effectively.
b) Solution strategy for complex engineering problems.	Has no solution strategy.	Can formulate some solution strategies but requires guidance to find strategies and solutions.	Develops and follows acceptable solution strategies. Able to solve moderately difficult engineering problems.	Develops and follows efficient strategy leading to correct solutions. Able to solve complex engineering problems.
c) Formulate and solve engineering problems using appropriate mathematics	Formulation is riddled with mistakes, unable to solve problems, or uses inappropriate mathematics.	Formulates and solves using somewhat appropriate mathematics but with numerous errors.	Formulates and solves using mostly appropriate mathematics with few mistakes.	Correctly formulates and solves engineering problems using appropriate mathematics without mistakes.
d) Formulate and solve engineering problems using sciences (defined as biological, chemical, or physical science) and device theory	Insufficient knowledge of physical sciences and inability to understand related concepts in electrical engineering (such as, solid state electronics and EM theory).	Understanding of physical sciences and ability to formulate and solve related simple problems in electrical engineering.	Able to formulate and solve problems, and also have the ability to correctly analyze and interpret related physical phenomena and structures.	In addition to the "Satisfactory" requirement, have the skills to analyze/solve complex problems or design simple electronic structures.

Outcome 2

An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Performance Indicator	Unsatisfactory	Marginal	Satisfactory	Exemplary
a) An ability to apply engineering design to produce a solution that meets specified needs	Unable to apply engineering design to produce a solution that meets specified needs.	Able to follow a provided design strategy to produce a solution that meets specified needs.	With some guidance, can develop and follow a design strategy to produce a solution that meets specified needs.	With little or no guidance, can develop and follow a design strategy to produce a solution that meets specified needs.
b) An ability to produce solutions that meet specific needs with consideration of public health, safety, and welfare, as well a global, cultural, social, environmental, and economic factors.	Unable to produce a solution that considers public health, safety, and welfare, as well global, cultural, social, environmental, and economic factors.	With complete guidance, can produce a solution that considers public health, safety, and welfare, as well global, cultural, social, environmental, and economic factors.	With some guidance, can produce a solution that considers public health, safety, and welfare, as well global, cultural, social, environmental, and economic factors.	With little or no guidance, can produce a solution that considers public health, safety, and welfare, as well global, cultural, social, environmental, and economic factors.
c) An ability to apply engineering design to produce a high-quality solution	Unable to apply engineering design to produce a solution that meets specified needs.	Able to apply engineering design to produce a solution that meets specified needs but the solution is not of high quality.	Able to apply engineering design to produce a high-quality solution that meets specified needs, and is able to analyze the quality of the solution.	Able to apply engineering design to produce multiple solutions that meets specified needs, able to analyze the quality of the solutions, and able to choose the best solution based on analysis.

Outcome 3

An ability to communicate effectively with a range of audiences.

The outcome has four performance criteria: (1) written report organization and style, (2) written report content, (3) oral presentation content, and (4) oral presentation delivery. For each performance criteria, we have a collection of hallmarks. The scoring rubrics are with respect to these hallmarks.

Written Report Organization and Style Hallmarks

- The report is organized into chapters and or sections including an introduction section and a conclusions, summary or final remarks section. The chapters and sections should be properly numbered and titled.
- There should be a description of the organization of the report presented somewhere at the beginning, e.g., in the introduction section. The description should briefly explain the chapters and sections to give the reader an overview.
- Sentences and paragraphs are clear and well organized.
- Chapters and sections are clear and well organized. There should be good transitions between paragraphs.
- There should be no spelling or grammatical errors.
- The report should follow any formatting instructions including but not limited to margins, font size, abstract, spacing, cover page format, etc.
- There should be a list of references and the list should follow the IEEE reference style or similar style.
- Figures and tables should be properly formatted. Figures should have captions and tables should have titles, and the captions and titles should be well written. Figures and tables should be numbered. They should appear either on the same page they are first referenced, after they are first referenced (e.g., on the next page), or in the back of the report.
- All unfamiliar technical terms should be italicized on first use and defined.
- Tables and figures should be properly referenced within the text of the report. Citations to the reference list should be done properly.

Written Report Content Hallmarks

- There should be a description of what the report is about including objectives, and if appropriate, motivation.
- The accomplishments and results are presented.
- Clear description of procedures and work involved is given.
- Background material is presented, such as previous work, modeling information, etc.
- Conclusions, summaries, and interpretations of the results are given wherever appropriate.
- There should be concluding statements including summary of task, and any suggestions for future work.
- A sufficient number of figures and tables are in the report. The figures and tables are clear, and they should improve the clarity of the report.
- References to other work and documents and all appropriate citations are given within the body of the report.

Oral Presentation Content Hallmarks

- Clear, strong thesis statement
- Main points were clear
- Main points were substantive
- Supporting evidence was provided when necessary
- Sources of information were cited.

- Review of main points were included in conclusion
- Concluding statement was clear - presentation ended smoothly

Oral Presentation Delivery Hallmarks

- Extemporaneous delivery
- Effective eye contact
- Clear vocal delivery
- Appropriate and effective language use
- Effective articulation and pronouncement of words
- Well-prepared slides (if appropriate) with sufficient figures and tables and or other appropriate visual and audio aids that communicates effectively with a wide range of audiences.
- Provides clear and appropriate answers

Performance Indicator	Unsatisfactory	Marginal	Satisfactory	Exemplary
a) Written report organization and style	Does not meet half of the hallmarks at a high level or there is at least one hallmark with no effort.	Meets at least half the hallmarks at a high level and has some effort in the remaining hallmarks.	Meets nearly all hallmarks at a high level and has some effort in the remaining hallmarks.	Meets all hallmarks at a high level.
b) Written report content	Does not meet half of the hallmarks at a high level or there is at least one hallmark with no effort.	Meets at least half the hallmarks at a high level and has some effort in the remaining hallmarks.	Meets all nearly all hallmarks at a high level and has some effort in the remaining hallmarks.	Meets all hallmarks at a high level.
c) Oral presentation content	Does not meet half of the hallmarks at a high level or there is at least one hallmark with no effort.	Meets at least half the hallmarks at a high level and has some effort in the remaining hallmarks.	Meets all nearly all hallmarks at a high level and has some effort in the remaining hallmarks.	Meets all hallmarks at a high level.
d) Oral presentation delivery	Does not meet half of the hallmarks at a high level or there is at least one hallmark with no effort.	Meets at least half the hallmarks at a high level and has some effort in the remaining hallmarks.	Meets all nearly all hallmarks at a high level and has some effort in the remaining hallmarks.	Meets all hallmarks at a high level.

Outcome 4

An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

Performance Indicator	Unsatisfactory	Marginal	Satisfactory	Exemplary
a) Demonstrate knowledge of ethical dilemmas and resolution approaches	Unable to recognize ethical dilemmas.	Able to recognize dilemmas but cannot indicate any path to resolution.	With some guidance, able to recognize dilemmas and can describe general dilemma resolution approaches.	With little or no guidance, able to recognize dilemmas and can describe dilemma resolution approaches.
b) Demonstrate knowledge of a professional engineering code of ethics	Unaware of any codes of ethical behavior.	Aware of the existence of the code of ethics, but confuses personal ethics with professional ethics.	Aware of various aspects of code of ethics, and can separate professional and personal ethics most of the time.	Aware of all aspects of code of ethics, and can separate professional and personal ethics all the time.
c) Evaluate the dimensions of professional engineering practices	Can only describe ethical issues or applications outside engineering or that do not clearly involve ethics.	Can distinguish engineering ethics from personal ethics.	Can show familiarity with tools for applying ethics to engineering practice.	Can describe an application of a professional code of ethics related to engineering, with a clear connection between the code provisions and the application.
d) Makes ethical and professional judgments while considering global, economic, environmental and societal impact	Unable to understand the impact in a global, economic, environmental and societal context.	Able to understand a few impacts, but unable to make informed judgments consistent with ethical and professional practice.	Able to understand most impacts, and is able to make informed judgments consistent with ethical and professional practice.	Able to understand, and can comprehensively analyze how an engineering solution might impact the global, economic, environment, and society. Is able to make judgments consistent with ethical and professional practice.

Outcome 5

An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

We use five performance indicators to measure this outcome:

(1) **Team Organization**: The project team is organized with different roles, including team lead, role for regular progress reporting, role for final written reporting, roles for oral presentation, etc.
(2) **Team Collaborations**: The project tasks are divided among team members, and team members work on the different parts of projects and integrate their work as a unified project.
(3) **Project Goals**: The team should identify the main project goals at different phases of the project (such as the beginning and the end of the project) in both written reports and oral presentations; the team also need to specify sub-goals in each task (or phase) of a project.
(4) **Project Plans**: The team should outline the overall plan for the project, and also draft concrete plans for each subtask (or phase)
(5) **Project Evaluation**: The team should identify evaluation methods and apply corresponding analysis to check if the project meets the goals.

Performance Indicator	Unsatisfactory	Marginal	Satisfactory	Exemplary
a) Team Organization	Not organized as a team; no clear roles or tasks are defined.	Loosely organized with some leadership; not well-defined team roles.	Tightly organized with leadership; clear-defined team roles.	Well organized as a team with strong leadership; clear-defined team roles.
b) Team Collaborations	Show almost no collaboration.	Very little collaboration; everyone performs individually.	Show clear collaboration among member.	Well-planned strong collaboration, and active interactions among members; show team effect.
c) Project Goals	No clear goals are defined.	Goals are defined but vague and not well-justified.	Clear goals are defined.	Clear goals are defined with strong motivations.
d) Project Plans	No concrete plans are given.	Plans are given but not-well-justified.	Clear plans are defined.	Clear plans are defined with solid ideas to achieve goals.
e) Project Evaluation	No justified evaluation to measure the achievement.	Some evaluation but not clearly measure if the objectives are achieved.	Good evaluation to measure if the objectives are achieved.	Carefully-designed evaluation methods to measure how well the objectives are achieved.

Outcome 6

An ability to develop and conduct experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Performance Indicator	Unsatisfactory	Marginal	Satisfactory	Exemplary
a) Experiment development	Unable to develop experiments. Has no knowledge of scientific methods, procedures, and tools.	Able to develop experiments only with assistance. Knows some scientific methods, procedures, and tools.	Able to develop simple experiments without assistance. Understands and uses proper scientific methods, procedures, and tools.	Able to develop more complex experiments, with little or no assistance. Understands and uses proper scientific methods, procedures, and tools.
b) Experiment execution	Unable to conduct experiments. Has to rely on other students or the instructor for the simplest of measurements.	Able to conducts experiment by following instructions, but is unable to modify/adapt if unanticipated issues arise.	Able to perform experiments with some degree of independence. Has basic ability to modify/adapt if problems arise.	Able to perform the experiments without any detailed instructions, and has the ability to independently resolve problems if they arise during execution.
c) Data collection, and analysis	Unable to gather any meaningful data. Is unaware of the concept of inaccuracy. Sees no need in data analysis. Reports purely unprocessed data, where clearly spurious results are never recognized	Able to collect very basic data. Is aware of some inaccuracies, and occasionally identifies some artifacts. Applies data analysis with major errors.	Able to collect most of appropriate data. Is aware of most artifacts, errors, and is able to identify them. Knows how to apply data analysis techniques satisfactorily.	Able to collect data, and is able to identify causes of inaccuracy, artifacts and errors. Can occasionally suggests solutions. Has good knowledge of data analysis, and applies them well.
d) Interpretation, and conclusion	Unable to interpret the data collected in the experiment. Makes no or erroneous conclusions.	Able to interpret some data, but with significant errors in interpretation and conclusions.	Able to correctly interpret most of the data; Exercises engineering judgment and most conclusions are correct or appropriate.	Able to correctly interpret most of the data, errors, artifacts, and occasionally can suggests solutions to improve. Makes correct interpretations, and demonstrates good engineering judgment to arrive at conclusions.

Outcome 7

An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Performance Indicator	Unsatisfactory	Marginal	Satisfactory	Exemplary
a) **Acquiring new knowledge using appropriate learning strategies**	Not aware of the need for new knowledge, and wait for someone to tell them what to do.	Aware of the need for new knowledge, but do not actively search and learn new tools and methods.	Actively search and learn new tools and methods.	Actively search and learn new tools and methods, and have a strategy for effective learning.
b) **Applying new knowledge**	Cannot identify deficiencies and new tools/methods needed for the project.	Able to identify deficiencies and new tools/methods needed, but is not able to use them very well.	Can identify deficiencies and new tools/methods needed in research, apply them in projects, with limited understanding of the theory or method behind the tools/techniques.	Can identify deficiencies and new tools/techniques needed in research, is able to master the use of them, and is able to explain the basic concepts and theory behind them.

Outcome 8

A knowledge of discrete mathematics.

Performance Indicator	Unsatisfactory	Marginal	Satisfactory	Exemplary
a) Apply Boolean algebra and logic	Doesn't know Boolean algebra or logic.	Partially understands Boolean algebra and logic.	Understands Boolean algebra and logic.	Can apply Boolean algebra and logic to design circuits and develop software.
b) Understands graphs, graph theory, and graph algorithms	Doesn't know what a tree data structure is.	Understands trees and binary search.	Can apply tree data structures and algorithms.	Can apply graphs, graph theory, and graph algorithms.
c) Analyze algorithms	Cannot prove anything.	Can analyze the time complexity of simple tree and sorting algorithms.	Can prove the correctness of simple tree and sorting algorithms and analyze their time complexities.	Can prove the correctness of simple graph algorithms and analyze their time complexities.
d) Understands counting formulas and discrete probability	Does not know counting formulas.	Can apply counting formulas.	Understands simple discrete probability theory.	Understands and can apply discrete probability and counting formulas.